The Effects of Forest Management Practices on Wild Bee Abundance and Functional Traits

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Introduction

- Both wild and managed bees are in decline due to the combined and interactive effects of anthropogenic disturbances such as habitat loss and pesticide use.[1, 2]
- This is concerning because bees are important not only for the pollination of agricultural lands, but also for plants in both natural and managed landscapes.[3, 4]
- North America is home to about 4000 native species of bees[5], all of which can be further classified by various characteristics such as body size, nesting strategy, diet breadth, and sociality.[6]
- These traits are considered functional traits because they can impact the function – pollination – bees contribute to an ecosystem.[6]
- The way we manage lands can impact bees[7], but these disturbances do not affect bee functional traits consistently.[8]
- Some forest management practices, including prescribed fire and thinning, can help maintain and restore forests.[9]
- While some research shows positive impacts of forest management on bees in general[10], results vary when looking at bee functional traits.[11]

Our main objectives were to assess how prescribed fire, thinning, and the combination of the two affect both bee abundance and body size.

Figure 1. Trail of Tears State Forest, Union County, Illinois.

Figure 2. Green sweat bee collected from Giant City State Park.

Methods (Field & Lab)

- All bees were collected in Southern Illinois on public forest lands at Trail of Tears State Forest, Giant City State Park, and Lake Murphysboro State Park.
- At each site location, there were 3 different treatments (prescribed fire, thinning, and thinning and prescribed fire) and 3 control plots (N = 29 total plots):
- We sampled bees in each plot once in early spring (April & March) and again in spring/early summer (May) using both passive and active sampling methods
- We then brought all specimens back to the laboratory and measured the length of the intertegular span (IT span) to determine body size.[12]
- We used a ZEISS Discovery.V8 microscope with a AxioCam ERc5s camera to take picture and the image software ZEN 2012 (blue edition) to measure the IT span.

Figure 3.Trail of Tears State Forest, Union County, Illinois; Plot 12 - control plot

Figure 4. Giant City State Park, Union County, Illinois; plot 6 – thin-burn treatment

Figure 5. Intertegular span (IT span) measurement of a Nomada sp. specimen

Methods (Statistics)

- All statistics were performed in R version 3.63 using the following packages: MASS, emmeans, ggplot2, and car.
- In order to assess how management type affected bee IT span (body size), we used a generalized linear model with a Poisson distribution and plotted the raw data.
- We then ran an ANOVA to understand how management type influenced the abundance of bees. We then plotted this model using least-square mean estimates. We further assessed significant differences in treatment category using a post hoc Tukey test.

Results

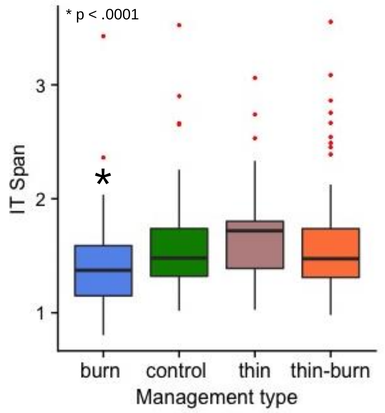

Figure 6. Management type (burn, control, thin, thin-burn) plotted against the IT span of all collected bee specimens (N = 619). Color differentiates management type. Asterisk designates a significant p-value (p < .05). Red points represent outliers. All data were collected in southern Illinois in 2021.

- We found a significant effect of burn treatment on the IT span of wild bees (p < .0001, z = 4.93). All other management types were insignificant.

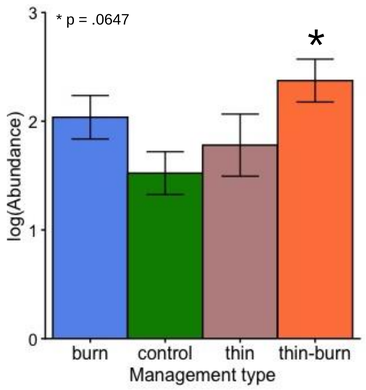

Figure 7. Least-square mean estimates of bee log(abundance) collected in each management type (burn, control, thin, thin-burn). Color differentiates management type. Asterisk designates marginal significance (p = .0647). All data were collected in southern Illinois in 2021.

- We found a significant effect of management type on abundance of wild bees (p < 0.0475, z = 2.866). After running a post hoc Tukey test, we found only a marginally significant effect in plots where both burning and thinning occurred (p = 0.0647). All other management types were insignificant.

Discussion

- The burn treatment was the only significant management type that affected the body size of bees. We found smaller bees in burn-only plots. Plots which received both prescribed fire and thinning had higher number of bees compared to others.
- Forest stands with the combination of prescribed fire and thinning might have a more open canopy, providing more light and resources for bees.[9] Availability of nesting resources might also explain observed differences.
- Other bee functional traits might respond differently to these treatments. [11]

Future Work

- We have collected data on various abiotic and biotic factors that might explain the relationship between forest management type and bee functional traits. We will use Light Detection and Ranging (LiDAR) data to measure the structural complexity of these plots as they relate to bee communities.
- In the future, we will assess other functional traits such as tongue length, sociality, diet breadth, nesting strategy, hairiness, parasitism, and scopa location.

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